

The documentation and process conversion measures necessary to comply with this revision shall be completed by 11 October 2021.

INCH-POUND

MIL-PRF-19500/712F
w/AMENDMENT 1
9 July 2021
SUPERSEDING
MIL-PRF-19500/712F
23 October 2017

PERFORMANCE SPECIFICATION SHEET

TRANSISTOR, FIELD EFFECT, P-CHANNEL, RADIATION HARDENED,
SILICON, ENCAPSULATED (THROUGH HOLE PACKAGE),
TYPES 2N7545, 2N7546, 2N7547, AND 2N7548,
JANTXVR, F, G, H AND JANSR, F, G, H

This specification is approved for use by all Departments and Agencies of the Department of Defense.

The requirements for acquiring the product described herein shall consist of this specification sheet and [MIL-PRF-19500](#).

1. SCOPE

1.1 Scope. This specification covers the performance requirements for a P-channel, enhancement-mode, MOSFET, radiation hardened (total dose and single event effects (SEE)), power transistor. Two levels of product assurance (JANTXV and JANS) are provided for each encapsulated device, with avalanche energy maximum rating (EAS) and maximum avalanche current (IAS). Provisions for radiation hardness assurance (RHA) to four radiation levels ("R", "F", "G", and "H") are provided for JANTXV and JANS product assurance levels. See 6.7 for JANHC and JANKC die versions.

1.2 Package outlines. The device package outlines are as follows: TO-257AA in accordance with [figure 1](#), SMD2 TO-276AA (U3) in accordance with [figure 2](#) for all encapsulated device types.

1.3 Maximum ratings. Unless otherwise specified, T_A = +25°C.

Type	P _T (1) T _C = +25°C	P _T T _A = +25°C (free air)	R _{θJC} (2)	V _{DS}	V _{DG}	V _{GS}	I _{D1} (3) (4) T _C = +25°C	I _{D2} (3) (4) T _C = +100°C	I _S (4)	I _{DM} (5)	T _J and T _{STG}	V _{ISO} 70,000 foot altitude
		<u>W</u>	<u>°C/W</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>A dc</u>	<u>A dc</u>	<u>A dc</u>	<u>A(pk)</u>	<u>°C</u>	<u>V dc</u>
2N7545U3	75	1.56	1.67	-100	-100	±20	-12.5	-8.0	-12.5	-50		100
2N7546U3	75	1.56	1.67	-200	-200	±20	-8.0	-5.0	-8.0	-32	-55 to	200
2N7547T3	75	1.56	1.67	-100	-100	±20	-12.5	-8.0	-12.5	-50	+150	100
2N7548T3	75	1.56	1.67	-200	-200	±20	-8.0	-5.0	-8.0	-32		200

(1) Derate linearly 0.6 W/°C for T_C > +25°C;

(2) See [figure 3](#), thermal impedance curves.

(3) The following formula derives the maximum theoretical I_D specs. I_D is limited by package and device construction:

$$I_D = \sqrt{\frac{T_{JM} - T_C}{(R_{\theta JC}) \times (R_{DS(on)} \text{ at } T_{JM})}}$$

(4) See [figure 4](#), maximum drain current graph.

(5) I_{DM} = 4 X I_{D1} as defined in note (3).

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1.4 Primary electrical characteristics. Unless otherwise specified, $T_C = +25^\circ\text{C}$.

Type	Min $V_{(BR)DSS}$ $V_{GS} = 0$ $I_D = 1.0$ mA dc	$V_{GS(TH)}$ $V_{DS} \geq V_{GS}$ $I_D = 1.0$ mA dc		Max I_{DSS1} $V_{GS} = 0$ $V_{DS} = 80$ percent of rated V_{DS}	Max $r_{DS(ON)}$ (1) $V_{GS} = 12$ V dc		EAS at I_{D1}	IAS
					$T_J = +25^\circ\text{C}$ at I_{D2}	$T_J = +150^\circ\text{C}$ at I_{D2}		
	V dc	V dc		μA dc	ohm	ohm	mJ	A
		Min	Max					
2N7545U3	-100	-2.0	-4.0	-10	0.205	0.472	96	-12.5
2N7546U3	-200	-2.0	-4.0	-10	0.505	1.162	75	-8.0
2N7547T3	-100	-2.0	-4.0	-10	0.215	0.473	94	-12.5
2N7548T3	-200	-2.0	-4.0	-10	0.515	1.185	80	-8.0

(1) Pulsed (see 4.5.1).

1.5 Part or Identifying Number (PIN). The PIN is in accordance with MIL-PRF-19500, and as specified herein. See 6.4 for PIN construction example and 6.5 for a list of available PINs.

1.5.1 JAN certification mark and quality level for encapsulated devices. The quality level designators for encapsulated devices that are applicable for this specification sheet from the lowest to the highest level are as follows: "JANTXV" and "JANS".

* 1.5.2 Radiation hardness assurance (RHA) designator. The RHA levels that are applicable for this specification sheet from lowest to highest are as follows: "R" "F", "G", and "H".

1.5.3 Device type. The designation system for the device types of transistors covered by this specification sheet are as follows.

1.5.3.1 First number and first letter symbols. The transistors of this specification sheet use the first number and letter symbols "2N".

1.5.3.2 Second number symbols. The second number symbols for the transistors covered by this specification sheet are as follows: "7545", "7546", "7547", and "7548".

1.5.3.3 Suffix letters. The suffix letters "T3" are used on devices (2N7547 and 2N7548 only) that are packaged in the TO-257A package of figure 1. The suffix letters "U3" are used on devices (2N7545 and 2N7546 only) that are packaged in the SMD2 TO-276AA package of figure 2.

1.5.4 Lead finish. The lead finishes applicable to this specification sheet are listed on QPDSIS-19500.

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* 1.6 Radiation features:

Maximum total ionizing dose (TID) available (Dose rate = 50-300 rad(Si)/s):

- For device type 2N7546U3: 1,000 krads(Si) 1/
- For device type 2N7545U3: 300 krads(Si) 1/
- For device type 2N7547T3, 2N7548T3: 100 krads(Si) 1/

Heavy Ion Single Event Effect (SEE) SEB and SEGR test:

For device types 2N7545U3 and 2N7547T3:

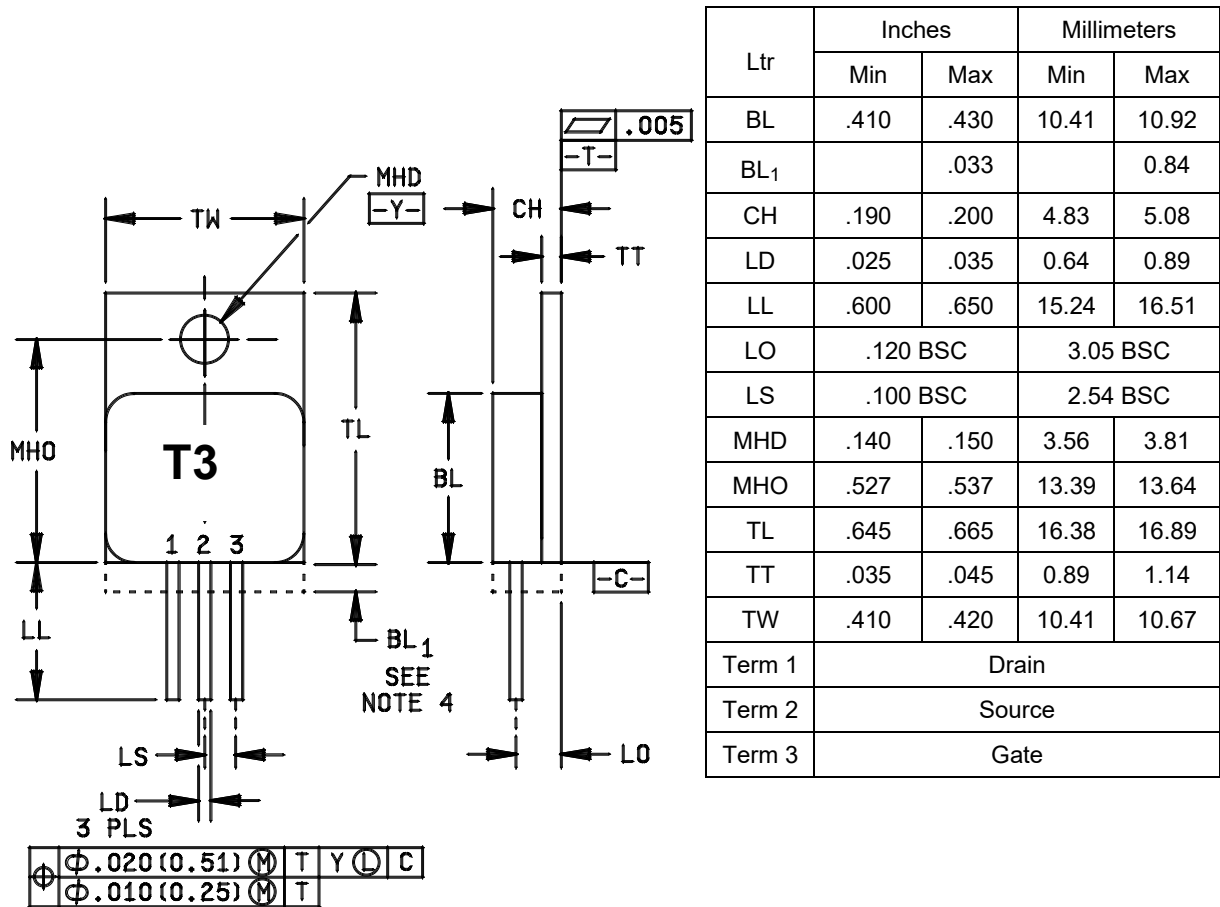
- No SEB and SEGR were observed at surface LET (see table IV) $\leq 84 \text{ MeV}\cdot\text{cm}^2/\text{mg}$ 2/
(In-situ Bias $V_{DS} = -100 \text{ V}$ and $V_{GS} = 10 \text{ V}$)
(In-situ Bias $V_{DS} = -30 \text{ V}$ and $V_{GS} = 15 \text{ V}$)

For device types 2N7546U3, and 2N7548T3:

- No SEB and SEGR were observed at surface LET (see table IV) $\leq 84 \text{ MeV}\cdot\text{cm}^2/\text{mg}$ 2/
(In-situ Bias $V_{DS} = -200 \text{ V}$ and $V_{GS} = 10 \text{ V}$)
(In-situ Bias $V_{DS} = -35 \text{ V}$ and $V_{GS} = 15 \text{ V}$)

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- 1/ Manufacturer supplying device types 2N7545U3, 2N7546U3, 2N7547T3, and 2N7548T3 has performed characterization testing in accordance with MIL-STD-750, method 1019, condition A (dose rate = 50 - 300 rad(Si)/s). The radiation end point limits are guaranteed only for the conditions as specified in MIL-STD-750, method 1019, condition A to a maximum total ionizing dose level of 1000 krads(Si) for device type 2N7546U3, 300 krads(Si) for device type 2N7545U3 and TID level of 100 krads(Si) for device type, 2N7547T3, 2N7548T3.
 - 2/ Manufacturer also performed heavy ion SEB and SEGR test at Brookhaven National Lab Accelerator and TAMU Radiation Effects Facility for the MOSFET technology devices in accordance with TM1080 of MIL-STD-750. Limits are characterized at initial qualification and after any design or process changes which may affect the SEE (SEB/SEGR) characteristics. For more information on SEE (SEB/SEGR) test results, customers are requested to contact the manufacturer.

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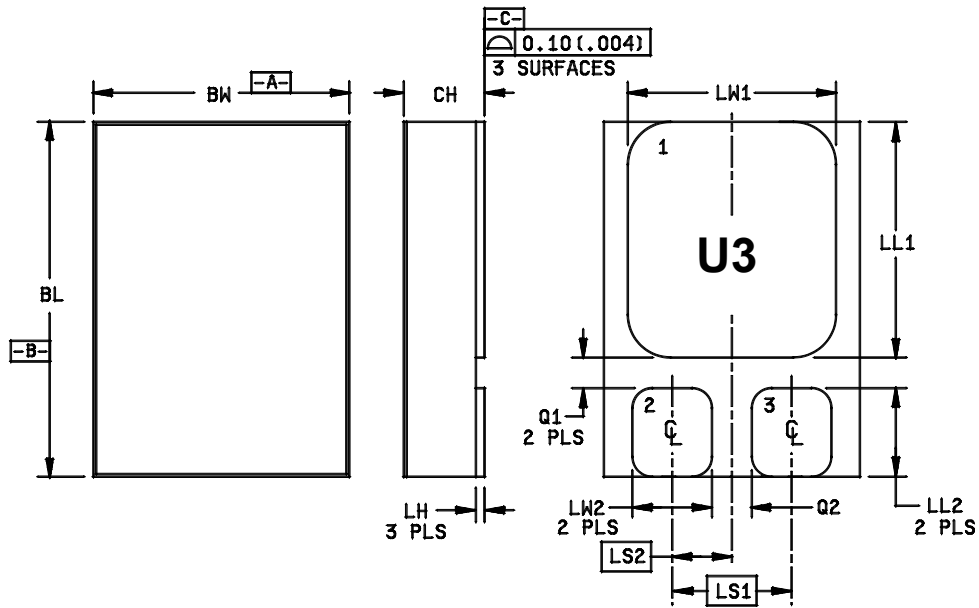


NOTES:

1. Dimensions are in inches.
 2. Millimeters are given for general information only.
 3. All terminals are isolated from the case.
 4. This area is for the lead feed-thru eyelets (configuration is optional, but will not extend beyond this zone).
- * 5. In accordance with ASME Y14.5, diameters are equivalent to ϕ x symbology.

* FIGURE 1. Physical dimensions for TO-257AA (2N7547T3 and 2N7548T3).

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Symbol	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
BL	.395	.405	10.04	10.28
BW	.291	.301	7.40	7.64
CH	.112	.123	2.84	3.12
LH	.010	.020	0.25	0.51
LW1	.281	.291	7.14	7.39
LW2	.090	.100	2.29	2.54
LL1	.220	.230	5.59	5.84
LL2	.115	.125	2.93	3.17
LS1	.150 BSC		3.81 BSC	
LS2	.075 BSC		1.91 BSC	
Q1	.030		0.762	
Q2	.030		0.762	
TERM 1	Drain			
TERM 2	Gate			
TERM 3	Source			

NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. In accordance with ASME Y14.5, diameters are equivalent to ϕ x symbology.
4. Terminal 1 - Drain, Terminal 2 - Gate, Terminal 3 - Source.

FIGURE 2. Physical dimensions for SMD.5 TO-276AA (2N7545U3 and 2N7546U3).

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

[MIL-PRF-19500](#) - Semiconductor Devices, General Specification for.

DEPARTMENT OF DEFENSE STANDARDS

[MIL-STD-750](#) - Test Methods for Semiconductor Devices.
* [MIL-STD-883](#) - Test Method Standard for Microcircuits.

(Copies of these documents are available online at <https://quicksearch.dla.mil/>).

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 General. The individual item requirements shall be as specified in [MIL-PRF-19500](#) and as modified herein.

3.2 Qualification. Devices furnished under this specification shall be products that are manufactured by a manufacturer authorized by the qualifying activity for listing on the applicable qualified manufacturer's list (QML) before contract award (see [4.2](#) and [6.3](#)).

3.3 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in [MIL-PRF-19500](#).

3.4 Interface and physical dimensions. The interface and physical dimensions shall be as specified in [MIL-PRF-19500](#) and on [figures 1](#) (T3, TO-257AA) and [2](#) (U3, surface mount TO-276AA) herein.

3.4.1 Lead finish. Lead finish shall be solderable in accordance with [MIL-PRF-19500](#), [MIL-STD-750](#), and herein. Where a choice of lead finish is desired, it shall be specified in the acquisition document (see [6.2](#)).

3.4.2 Internal construction. Multiple chip construction shall not be permitted to meet the requirements of this specification.

* 3.4.3 Silicone die coating. The use of a silicone die coat requires a successful completion of [MIL-STD-883](#), method [5011](#) on each silicone lot for its intended applications, and as part of the full [MIL-PRF-19500](#) qualification process.

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3.5 Electrostatic discharge sensitive (ESDS). The devices covered by this specification sheet have been classified as ESDS. The devices shall be handled in accordance with the ESD program established to comply with the requirements of [MIL-PRF-19500](#) to avoid damage due to the accumulation of static charge. The following handling practices shall be followed:

- a. Devices should be handled on benches with conductive handling devices.
- b. Ground test equipment, tools, and personnel handling devices.
- c. Do not handle devices by the leads.
- d. Store devices in conductive foam or carriers.
- e. Avoid use of plastic, rubber, or silk in MOS areas.
- f. Maintain relative humidity above 50 percent if practical.
- g. Care should be exercised during test and troubleshooting to apply not more than maximum rated voltage to any lead.
- h. Gate shall be terminated to source, $R \leq 100 \text{ k}\Omega$, whenever bias voltage is to be applied drain to source.

3.6 Electrical performance characteristics. Unless otherwise specified herein, the electrical performance characteristics are as specified in [1.3](#), [1.4](#), and [table I](#) herein.

3.7 Electrical test requirements. The electrical test requirements shall be as specified in [table I](#).

3.8 Marking. Marking shall be in accordance with [MIL-PRF-19500](#). At the option of the manufacturer, marking may be omitted from the body, but shall be retained on the initial container.

3.9 Workmanship. Semiconductor devices shall be processed in such a manner as to be uniform in quality and shall be free from other defects that will affect life, serviceability, or appearance.

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

- a. Qualification inspection (see [4.2](#)).
- b. Screening (see [4.3](#)).
- c. Conformance inspection (see [4.4](#) and [tables I and II](#)).

4.2 Qualification inspection. Qualification inspection shall be in accordance with [MIL-PRF-19500](#) and as specified herein.

4.2.1 Group E qualification. Group E inspection shall be performed for qualification or re-qualification only. In case qualification was awarded to a prior revision of the specification sheet that did not request the performance of [table III](#) tests, the tests specified in [table III](#) herein that were not performed in the prior revision shall be performed on the first inspection lot of this revision to maintain qualification.

* 4.2.1.1 Single event effects (SEE). SEE (SEB/SEGR) shall be performed in accordance with TM1080 of MIL-STD-750 at initial qualification and after process or design changes which may affect radiation hardness (see [table III](#) and [table IV](#)). Upon qualification, manufacturers shall provide the verification test conditions from section 5 of method 1080 of [MIL-STD-750](#) that were used to qualify the device for inclusion into section 6 of the slash sheet. End-point measurements shall be in accordance with [table II](#). SEE characterization data shall be made available upon request of the qualifying or acquiring activity.

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4.3 Screening (JANS and JANTXV levels only). Screening shall be in accordance with table E-IV of MIL-PRF-19500 and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

Screen (1) (2)	Measurement	
	JANS level	JANTXV level
(3)	Gate stress test (see 4.3.1)	Gate stress test (see 4.3.1)
(3)	Method 3470 of MIL-STD-750, E _{AS} (see 4.3.2)	Method 3470 of MIL-STD-750, E _{AS} (see 4.3.2)
(3) 3c	Method 3161 of MIL-STD-750, thermal impedance (see 4.3.3)	Method 3161 of MIL-STD-750, thermal impedance (see 4.3.3)
5	Method 2052 of MIL-STD-750, PIND (see MIL-PRF-19500 and 4.3.5)	Not applicable
(1) 9	Subgroup 2 of table I herein; I _{GSSF1} , I _{GSSR1} , I _{DSS1}	Not applicable
10	Method 1042 of MIL-STD-750, test condition B	Method 1042 of MIL-STD-750, test condition B
11	Subgroup 2 of table I herein; I _{GSSF1} , I _{GSSR1} , I _{DSS1} , r _{DS(on)1} , V _{GS(TH)1} Δ I _{GSSF1} = ±20 nA dc or ±100 percent of initial value, whichever is greater. Δ I _{GSSR1} = ±20 nA dc or ±100 percent of initial value, whichever is greater. Δ I _{DSS1} = ±10 μA dc or ±100 percent of initial value, whichever is greater.	Subgroup 2 of table I herein; I _{GSSF1} , I _{GSSR1} , I _{DSS1} , r _{DS(on)1} , V _{GS(TH)1}
12	Method 1042 of MIL-STD-750, test condition A	Method 1042 of MIL-STD-750, test condition A or T _A = +175°C, t = 48 hours.
13	Subgroups 2 and 3 of table I herein; Δ I _{GSSF1} = ±20 nA dc or ±100 percent of initial value, whichever is greater. Δ I _{GSSR1} = ±20 nA dc or ±100 percent of initial value, whichever is greater. Δ I _{DSS1} = ±10 μA dc or ±100 percent of initial value, whichever is greater. Δ r _{DS(on)1} = ±20 percent of initial value. Δ V _{GS(TH)1} = ±20 percent of initial value.	Subgroups 2 and 3 of table I herein; Δ I _{GSSF1} = ±20 nA dc or ±100 percent of initial value, whichever is greater. Δ I _{GSSR1} = ±20 nA dc or ±100 percent of initial value, whichever is greater. Δ I _{DSS1} = ±10 μA dc or ±100 percent of initial value, whichever is greater. Δ r _{DS(on)1} = ±20 percent of initial value. Δ V _{GS(TH)1} = ±20 percent of initial value.
17	For TO-257 and U3 packages: Method 1081 of MIL-STD-750 (see 4.3.4), Endpoints: Subgroup 2 of table I herein.	For TO-257 and U3 packages: Method 1081 of MIL-STD-750 (see 4.3.4), Endpoints: Subgroup 2 of table I herein.

- (1) At the end of the test program, I_{GSSF1}, I_{GSSR1}, and I_{DSS1} are measured.
(2) An out-of-family program to characterize I_{GSSF1}, I_{GSSR1}, I_{DSS1}, V_{GS(th)1}, and r_{DS(ON)1} shall be invoked.
(3) Shall be performed anytime after temperature cycling, screen 3a; -JANTXV level does not need to be repeated in screening requirements.

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4.3.1 Gate stress test. Apply $V_{GS} = -24$ V minimum for $t = 250$ μ s minimum.

4.3.2 Single pulse avalanche energy (E_{AS}).

- a. Peak current (I_{AS}) $I_{AS(max)}$.
- b. Peak gate voltage (V_{GS})12 V.
- c. Gate to source resistor (R_{GS}) $25\Omega \leq R_{GS} \leq 200\Omega$.
- d. Initial case temperature (T_C)+25°C +10°C, -5°C.
- e. Inductance (L)..... $\left[\frac{2E_{AS}}{(I_{DI})^2} \right] \left[\frac{(V_{BR} - V_{DD})}{V_{BR}} \right] mH$ minimum.
- f. Number of pulses to be applied1 pulse minimum.
- g. Supply voltage (V_{DD})50 V.

4.3.3 Thermal impedance. The thermal impedance measurements shall be performed in accordance with method 3161 of [MIL-STD-750](#) using the guidelines in that method for determining I_M , I_H , t_H , t_{sw} , (and V_H where appropriate). Measurement delay time (t_{MD}) = 70 μ s maximum. See [table III](#), group E, subgroup 4 herein.

4.3.4 Dielectric withstanding voltage.

- a. Magnitude of test voltage.....800 V dc (TO-257), 600 V dc (U3).
- b. Duration of application of test voltage.....15 seconds (min).
- c. Points of application of test voltage.....All leads to case (bunch connection).
- d. Method of connection.....Mechanical.
- e. Kilovolt-ampere rating of high voltage source.....1,200 V/1.0 mA (min).
- f. Maximum leakage current.....1.0 mA.
- g. Voltage ramp up time.....500 V/second

* 4.3.5 PIND. Not applicable in screening when devices are processed using alternative method and flow requirements approved by the qualifying activity, that includes incorporating the use of certified clean processing and silicone die coat. Instead, the PIND test performance shall be performed in group B3 and group C3, on a lot sample basis. PIND failures detected in group B or C will represent lot jeopardy and shall be evaluated for root cause and lot integrity.

4.4 Conformance inspection. Conformance inspection shall be in accordance with [MIL-PRF-19500](#), and as specified herein.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with table E-V of [MIL-PRF-19500](#). End-point electrical measurements shall be in accordance with [table I](#), subgroup 2 herein.

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4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-VIA (JANS) and table E-VIB (JANTXV) of [MIL-PRF-19500](#), and herein.

4.4.2.1 Quality level JANS, table E-VIA of [MIL-PRF-19500](#).

<u>Subgroup</u>	<u>Method</u>	<u>Conditions</u>
B3	1051	Test condition G, 100 cycles.
B3	2075	See 3.4.2 herein.
B3	2037	Test condition D.
B3	2077	Scanning electron microscope (SEM) qualification may be performed anytime prior to lot formation.
* B3	2052	PIND, required if not performed in screening. (22 devices, c = 0 for large lots, 12 devices, c = 0 for small lots).
B4	1042	Condition D. No heat sink nor forced-air cooling on the device shall be permitted during the on cycle. The heating cycle shall be 60 seconds minimum.
* B5	1042	Test condition B, $V_{GS} = \text{rated}$; $T_A = +175^\circ\text{C}$; t = 24 hours; or $T_A = +150^\circ\text{C}$, t = 48 hours minimum.
* B5	1042	Test condition A, $V_{DS} = \text{rated}$; $T_A = +175^\circ\text{C}$; t = 120 hours; or $T_A = +150^\circ\text{C}$, t = 240 hours minimum.

4.4.2.2 Quality level JANTXV, table E-VIB of [MIL-PRF-19500](#).

<u>Subgroup</u>	<u>Method</u>	<u>Conditions</u>
B2	1051	Test condition G, 25 cycles. (45 total, including 20 cycles performed in screening).
B3	1042	Test condition D. No heat sink nor forced-air cooling on the device shall be permitted during the on cycle. The heating cycle shall be 60 seconds minimum.
B3	2037	Test condition D.
B4	2075	See 3.4.2 herein.

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4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-VII of [MIL-PRF-19500](#) and as follows.

<u>Subgroup</u>	<u>Method</u>	<u>Conditions</u>
C2	1056	Test condition B.
C2	2036	Test condition A, weight = 10 lbs (4.5.4Kg), t = 10 s (applicable to TO-257AA only).
C2	1021	Omit initial conditioning.
* C3	2052	PIND, required if not performed in screening. (JANS only, 22 devices, c = 0 for large lots, 12 devices, c = 0 for small lots).
C5	3161	Thermal resistance, see 4.3.3 , $R_{\theta JC(max)} = 1.67^{\circ}C/W$.
C6	1042	Test condition D. No heat sink nor forced-air cooling on the device shall be permitted during the on cycle. The heating cycle shall be 60 seconds minimum.
C6	2037	Test condition D.

4.4.4 Group D inspection. Group D inspection shall be conducted in accordance with table E-VIII of [MIL-PRF-19500](#) and [table II](#) herein.

4.4.5 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-IX of [MIL-PRF-19500](#) and as specified herein.

4.5 Methods of inspection. Methods of inspection shall be as specified in the appropriate tables and as follows.

4.5.1 Pulse measurements. Conditions for pulse measurement shall be as specified in section 4 of [MIL-STD-750](#).

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TABLE I. Group A inspection.

Inspection <u>1</u> /	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical inspection	2071					
Subgroup 2						
Thermal impedance <u>2</u> /	3161	See 4.3.3	$Z_{\theta JC}$			°C/W
Breakdown voltage, drain to source	3407	$V_{GS} = 0$ V dc, $I_D = -1$ mA dc, bias condition C	$V_{(BR)DSS}$			
2N7545U3, 2N7547T3 2N7546U3, 2N7548T3				-100 -200		V dc V dc
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$, $I_D = -1$ mA dc	$V_{GS(TH)1}$	-2.0	-4.0	V dc
Gate reverse current	3411	$V_{GS} = +20$ V dc, bias condition C, $V_{DS} = 0$	I_{GSSF1}		+100	nA dc
Gate reverse current	3411	$V_{GS} = -20$ V dc, bias condition C, $V_{DS} = 0$	I_{GSSR1}		-100	nA dc
Drain current	3413	$V_{GS} = 0$ V dc, bias condition C, $V_{DS} = 80$ percent of rated V_{DS}	I_{DSS1}		-10	μA dc
Static drain to source on-state resistance	3421	$V_{GS} = -12$ V dc, condition A, pulsed (see 4.5.1), $I_D = I_{D2}$	$r_{DS(on)1}$			
2N7545U3 2N7546U3 2N7547T3 2N7548T3					0.205 0.505 0.215 0.515	Ω Ω Ω Ω
Forward voltage	4011	Pulsed (see 4.5.1), condition A, $I_D = I_{D1}$, $V_{GS} = 0$ V dc	V_{SD}		-5.0	V dc

See footnotes at end of table.

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TABLE I. Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 3</u>						
High temperature operation:						
Gate reverse current	3411	$T_C = T_J = +125^\circ\text{C}$ $V_{GS} = -20\text{ V dc and } +20\text{ V dc, bias condition C, } V_{DS} = 0$	I_{GSS2}		± 200	nA dc
Drain current	3413	$V_{GS} = 0\text{ V dc, bias condition C, } V_{DS} = 80\text{ percent of rated } V_{DS}$	I_{DSS2}		-0.025	mA dc
Static drain to source on state resistance	3421	Condition A, $V_{GS} = -12\text{ V dc, pulsed (see 4.5.1), } I_D = I_{D2}$	$r_{DS(on)3}$			
2N7545U3					0.43	Ω
2N7546U3					1.02	Ω
2N7547T3					0.45	Ω
2N7548T3					1.03	Ω
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}, I_D = -1\text{ mA dc}$	$V_{GS(TH)2}$	-1.0		V dc
Low temperature operation:						
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}, I_D = -1\text{ mA dc}$	$V_{GS(TH)3}$		-5.0	V dc
<u>Subgroup 4</u>						
Forward transconductance	3475	$I_D = \text{rated } I_{D2}, V_{DD} = -15\text{ V (see 4.5.1)}$	gFS			
2N7545U3				6.3		S
2N7546U3				5.4		S
2N7547T3				6.8		S
2N7548T3				5.1		S
Switching time test	3472	$I_D = \text{rated } I_{D1}, V_{GS} = -12\text{ V dc, } R_G = 7.5\Omega, V_{DD} = 50\text{ percent of rated } V_{DS}$				
Turn on delay time			$t_{d(on)}$			
2N7545U3					25	ns
2N7546U3					25	ns
2N7547T3					25	ns
2N7548T3					25	ns
Rise-time			t_r			
2N7545U3					55	ns
2N7546U3					35	ns
2N7547T3					55	ns
2N7548T3					30	ns

See footnotes at end of table.

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TABLE I. Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 4</u> - Continued						
Turn-off delay time			$t_{d(off)}$			
2N7545U3					33	ns
2N7546U3					50	ns
2N7547T3					33	ns
2N7548T3					50	ns
Fall time			t_f			
2N7545U3					103	ns
2N7546U3					105	ns
2N7547T3					105	ns
2N7548T3					105	ns
<u>Subgroup 5</u>						
Safe operating area test (high voltage)	3474	See figure 5 ; $t_p = 10$ ms, $V_{DS} = 80$ percent of rated V_{DS}				
Electrical measurements		See table I , subgroup 2 herein.				
<u>Subgroup 6</u>						
Not applicable						
<u>Subgroup 7</u>						
Gate charge	3471	Condition B				
On-state gate charge			$Q_{G(ON)}$		45	nC
Gate to source charge			Q_{GS}			
2N7545U3, 2N7547T3					16	nC
2N7546U3, 2N7548T3					12	nC
Gate to drain charge			Q_{GD}			
2N7545U3, 2N7547T3					11	nC
2N7546U3, 2N7548T3					15	nC
Reverse recovery time	3473	Condition A, $di/dt \leq 100A/\mu s$, $V_{DD} \leq 50$ V, $I_D = I_{D1}$	t_{rr}			
2N7545U3					191	ns
2N7546U3					180	ns
2N7547T3					191	ns
2N7548T3					200	ns

1/ For sampling plan, see [MIL-PRF-19500](#).

2/ For end-point measurements, this test is required for the following subgroups:
 Group B, subgroups 2 and 3 (JANTXV).
 Group B, subgroups 3 and 4 (JANS).
 Group C, subgroup 2 and 6.
 Group E, subgroup 1.

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TABLE II. Group D inspection.

Inspection <u>1/ 2/ 3/</u>	MIL-STD-750		Symbol	Pre-irradiation limits		Post-irradiation limits		Post-irradiation limits		Unit
	Method	Conditions		R, F, G, H		R		F, G, H <u>4/</u>		
				Min	Max	Min	Max	Min	Max	
<u>Subgroup 1</u>										
Not applicable										
<u>Subgroup 2</u>		T _C = +25°C								
* Steady-state total dose irradiation (V _{GS} bias) <u>5/</u>	1019	Condition A, V _{GS} = -12V V _{DS} = 0								
* Steady-state total dose irradiation (V _{DS} bias) <u>5/</u>	1019	Condition A, V _{GS} = 0 V _{DS} = 80 percent of rated V _{DS} (pre-irradiation)								
End-point electricals:										
Breakdown voltage, drain to source	3407	V _{GS} = 0 I _D = -1 mA bias cond. C	V _{(BR)DSS}							
2N7545U3,				-100		-100		-100		V dc
2N7547T3,				-200		-200		-200		V dc
2N7546U3,										
2N7548T3										
Gate to source voltage (threshold)	3403	V _{DS} ≥ V _{GS}	V _{GStH1}	-2.0	-4.0	-2.0	-4.0	-2.0	-5.0	V dc
Gate reverse current	3411	V _{GS} = -20 V V _{DS} = 0 bias cond. C	I _{GSSR1}		-100		-100		-100	nA dc
Gate forward current	3411	V _{GS} = 20 V V _{DS} = 0 bias cond. C	I _{GSSF1}		100		100		100	nA dc
Drain current	3413	V _{GS} = 0 bias cond. C V _{DS} = 80 percent of rated V _{DS} (pre-irradiation)	I _{DSS1}		-10		-10		-10	μA dc

See footnotes at end of table.

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TABLE II. Group D inspection - Continued.

Inspection <u>1/</u> <u>2/</u> <u>3/</u>	MIL-STD-750		Symbol	Pre-irradiation limits		Post-irradiation limits		Post-irradiation limits		Unit
	Method	Conditions		R, F, G, H		R		F, G, H <u>4/</u>		
				Min	Max	Min	Max	Min	Max	
<u>Subgroup 2</u> - continued										
Static drain to source on-state voltage	3405	$V_{GS} = -12$ V condition A pulsed (see 4.5.1) $I_D = I_{D2}$	V_{DSon1}							
2N7545U3					1.640		1.640		1.640	V dc
2N7546U3					2.525		2.525		2.525	V dc
2N7547T3					1.720		1.720		1.720	V dc
2N7548T3					2.575		2.575		2.575	V dc
Forward voltage source to drain diode	4011	Condition A, $V_{GS} = 0$, $I_D = I_{D1}$	V_{SD}		-5.0		-5.0		-5.0	V dc

1/ For sampling plan, see [MIL-PRF-19500](#).

2/ Group D qualification may be performed anytime prior to lot formation. Wafers qualified to these group D QCI requirements may be used for any other specification sheet utilizing the same die design.

3/ At the manufacturer's option, group D samples need not be subjected to the screening tests, and may be assembled in its qualified package or in any qualified package that the manufacturer has data to correlate the performance to the designated package.

4/ The "F" designation represents devices which pass end-points at the R and F designated total-ionizing-dose (TID).

5/ Separate samples shall be pulled for each bias.

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TABLE III. Group E inspection (all quality levels) for qualification or re-qualification only.

Inspection	MIL-STD-750		Sample plan
	Method	Conditions	
<u>Subgroup 1</u>			45 devices c = 0
Temperature cycling	1051	Test condition G, 500 cycles.	
Hermetic seal Fine leak Gross leak	1071	As applicable.	
Electrical measurements		See table I , subgroup 2.	
<u>Subgroup 2 1/</u>			45 devices c = 0
Steady-state reverse bias	1042	Condition A, 1,000 hours.	
Electrical measurements		See table I , subgroup 2.	
Steady-state gate bias	1042	Condition B, 1,000 hours.	
Electrical measurements		See table I , subgroup 2.	
<u>Subgroup 4</u>			Sample size N/A
Thermal impedance curves		See MIL-PRF-19500 .	
<u>Subgroup 5</u>			3 devices c = 0
Barometric pressure (reduced)	1001	$V_{DS} = \text{rated } V_{(BR)DSS}, I_{(ISO)} < 0.25 \text{ mA}$.	
<u>Subgroup 10</u>			22 devices c = 0
Commutating diode for safe operating area test procedure for measuring dv/dt during reverse recovery of power MOSFET transistors or insulated gate bipolar transistors	3476	Test conditions shall be derived by the manufacturer.	
<u>Subgroup 11</u>			3 devices
SEE <u>2/ 3/</u>	1080	See method 1080 of MIL-STD-750 .	

1/ A separate sample for each test shall be pulled.

2/ Group E qualification of SEE testing may be performed prior to lot formation. Qualification may be extended to other specification sheets utilizing the same structurally identical die design.

3/ The sampling plan applies to each bias condition.

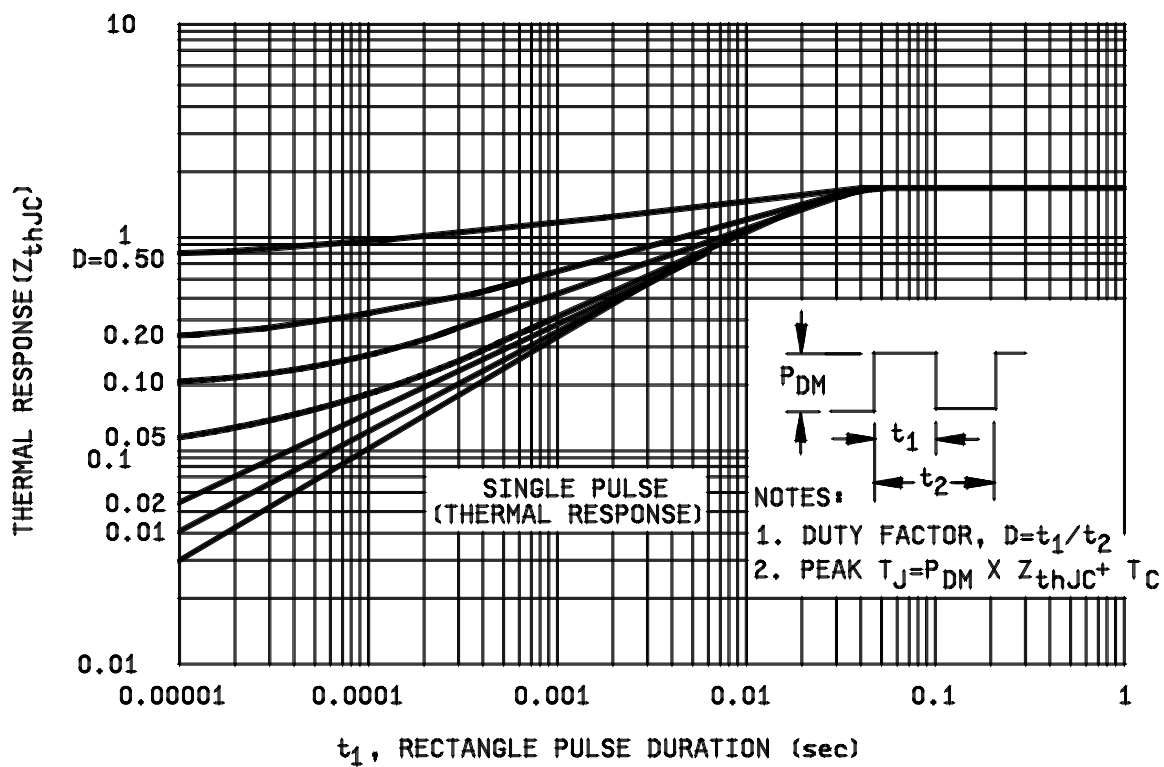


FIGURE 3. Thermal impedance curves.

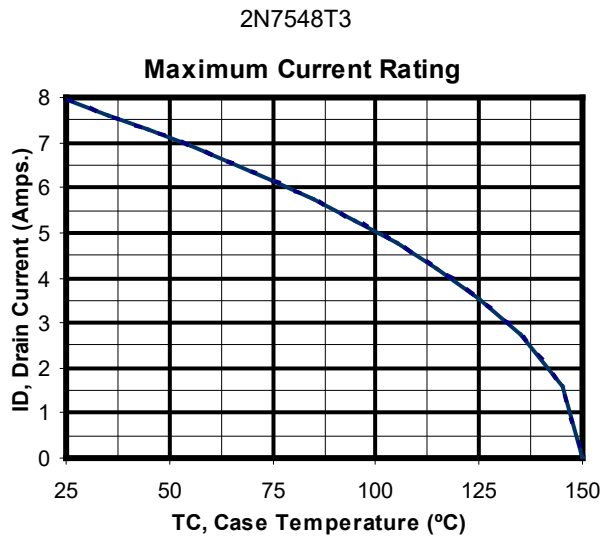
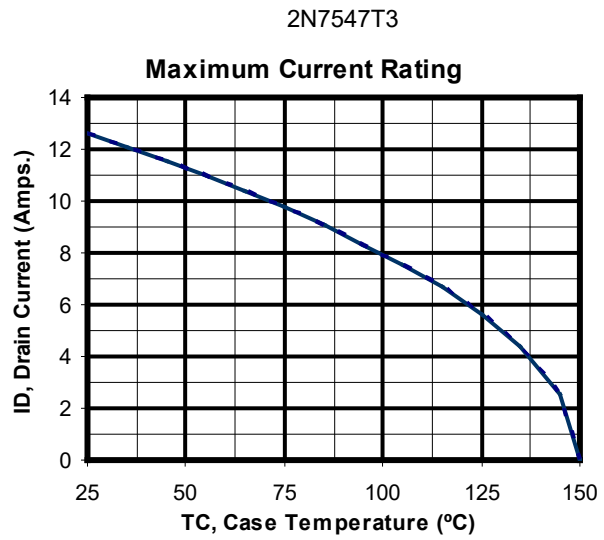
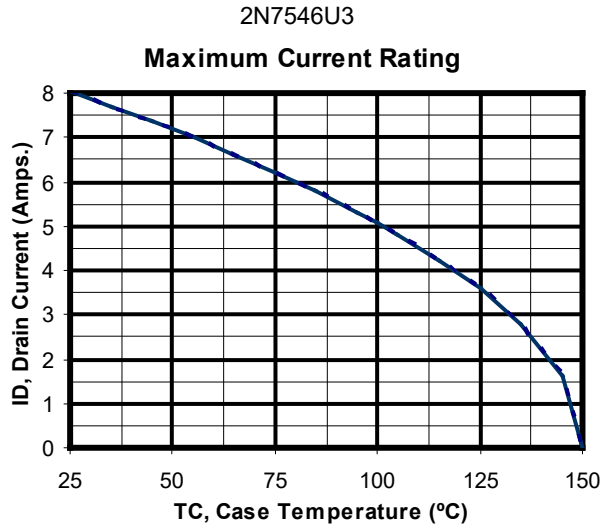
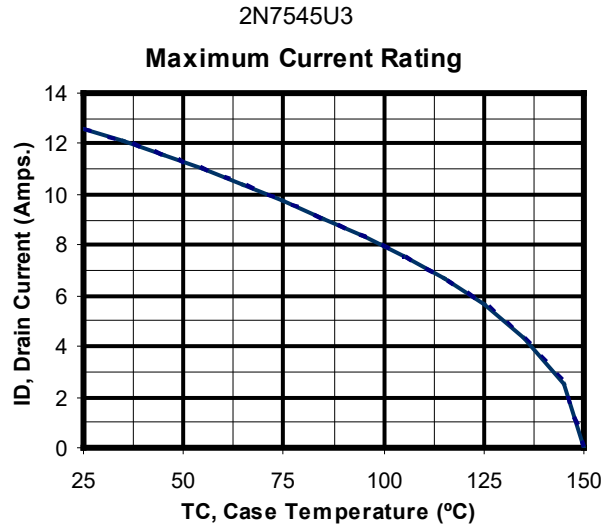


FIGURE 4. Maximum drain current vs case temperature graphs.

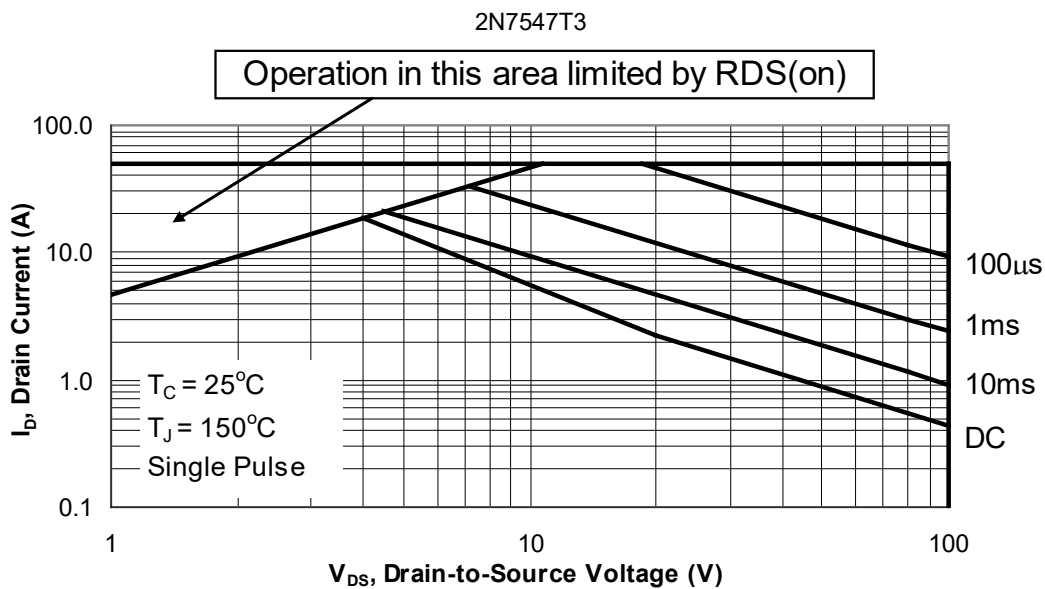
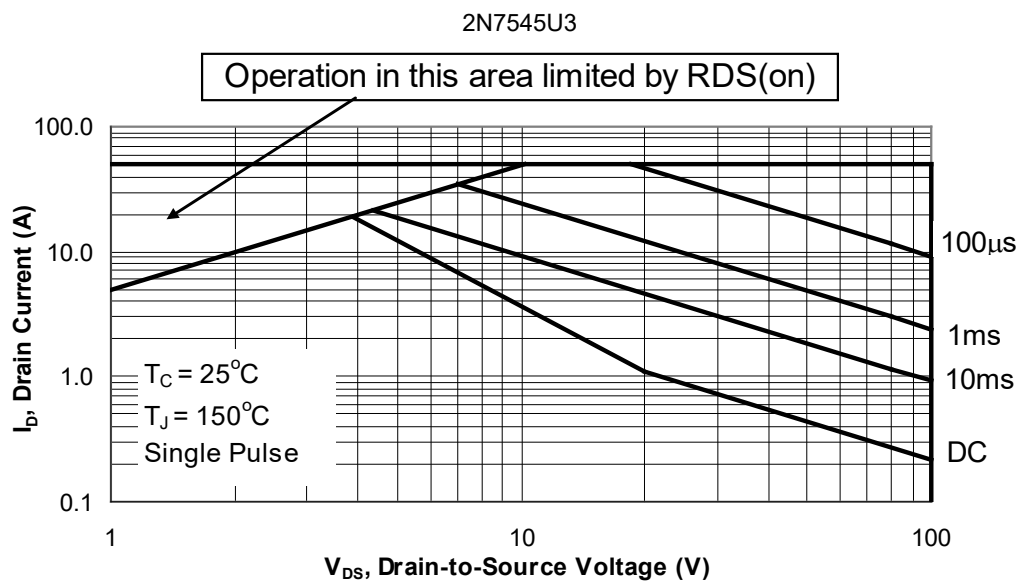


FIGURE 5. Safe operating area graph.

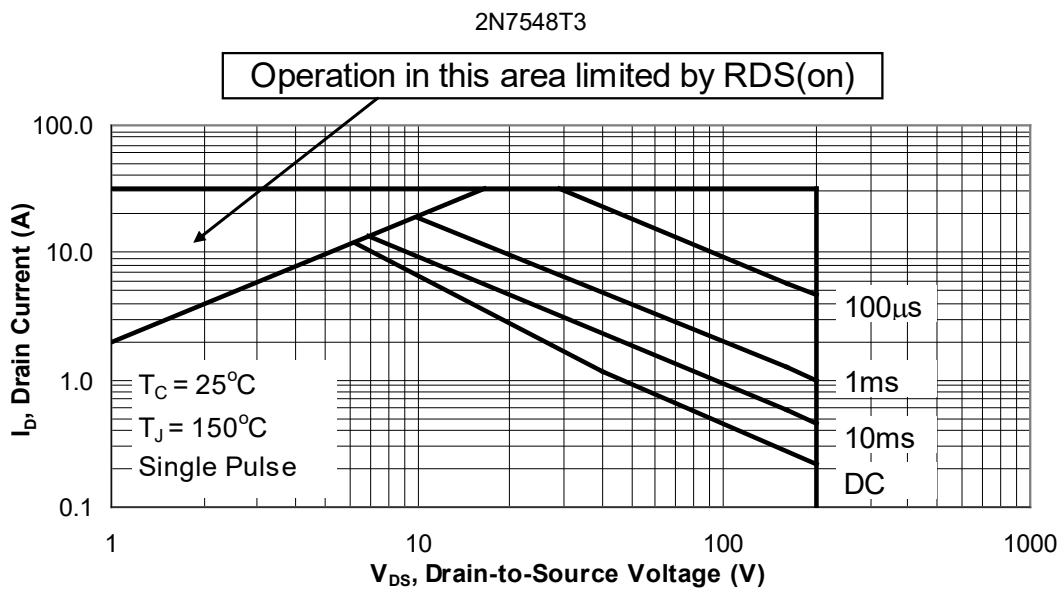
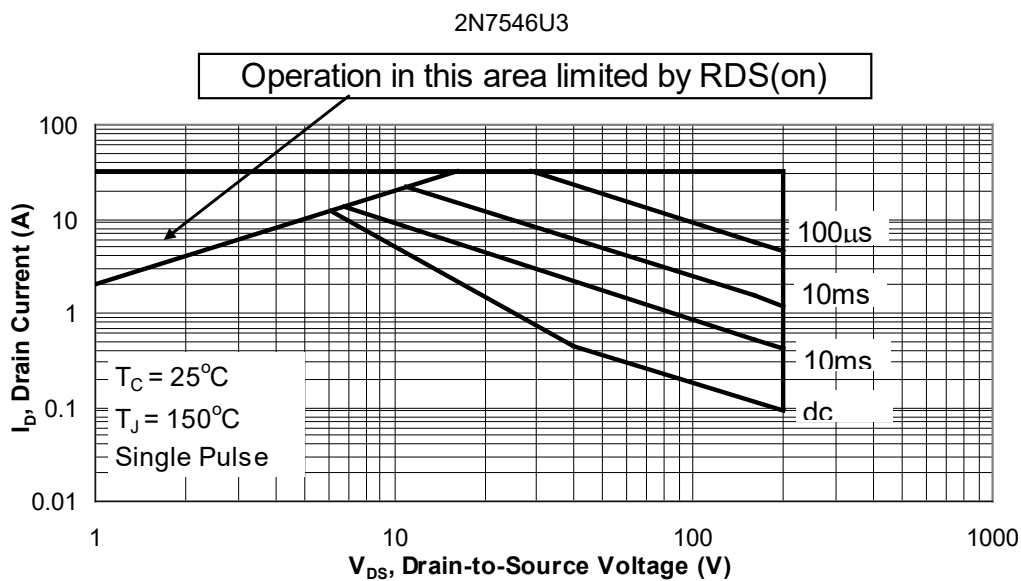


FIGURE 5. Safe operating area graph. - Continued.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the Military Service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory. The notes specified in [MIL-PRF-19500](#) are applicable to this specification.)

6.1 Intended use. Semiconductors conforming to this specification are intended for original equipment design applications and logistic support of existing equipment.

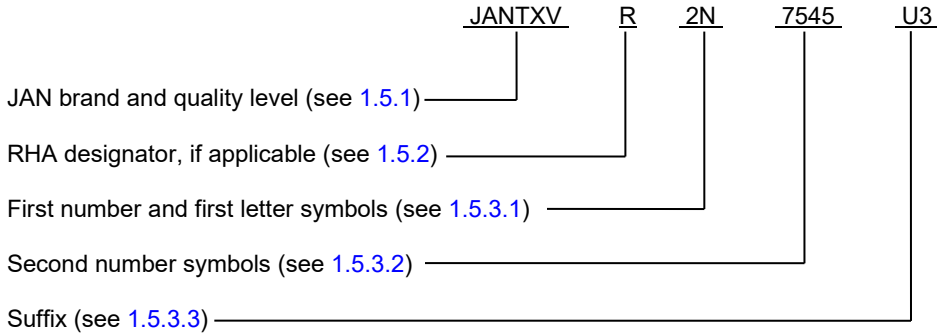
6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. Packaging requirements (see 5.1).
- c. Lead finish (see [3.4.1](#)).
- d. The complete PIN, see [1.5](#) and [6.5](#).
- e. For acquisition of RHA designated devices, [table II](#), subgroup 1 testing of group D herein is optional. If subgroup 1 is desired, it should be specified in the contract.
- f. If specific SEE characterization conditions are desired (see section [6.8](#) and [table IV](#)), manufacturer's cage code should be specified in the contract or order.
- g. If SEE testing data is desired, it should be specified in the contract or order.

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Manufacturers List ([QML 19500](#)) whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from DLA Land and Maritime, ATTN: VQE, P.O. Box 3990, Columbus, OH 43218-3990 or e-mail vqe.chief@dla.mil. An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at <https://assist.dla.mil>.

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6.4 PIN construction example. The PINs for encapsulated devices are construction using the following form.



6.5 List of PINs. The following is a list of possible PINs available on this specification sheet.

PINs for devices of the "TXV" quality level	PINs for devices of the "TXV" quality level with RHA (1)	PINs for devices of the "S" quality level	PINs for devices of the "S" quality level with RHA (1)
JANTXV2N7545U3	JANTXV#2N7545U3	JANS2N7545U3	JANS#2N7545U3
JANTXV2N7546U3	JANTXV#2N7546U3	JANS2N7546U3	JANS#2N7546U3
JANTXV2N7547T3	JANTXV#2N7547T3	JANS2N7547T3	JANS#2N7547T3
JANTXV2N7548T3	JANTXV#2N7548T3	JANS2N7548T3	JANS#2N7548T3

(1) The number sign (#) represents one of four RHA designators available on this specification sheet ("R", "F", "G", or "H").

6.6 Substitution information. Devices covered by this specification are substitutable for the manufacturer's and user's Part or Identifying Number (PIN). This information in no way implies that manufacturer's PIN's are suitable for the military PIN.

Preferred types (military PIN)	Commercial PIN	
	TO-257AA	SMD.5
2N7545U3		IRHNJ597130
2N7546U3		IRHNJ597230
2N7547T3	IRHY597130CM	
2N7548T3	IRHY597230CM	

6.7 JANC die versions. The JANHC and JANKC die versions of these devices are covered under specification sheet [MIL-PRF-19500/741](#).

6.8 Application data.

* 6.8.1 Manufacturer specific irradiation data. Each manufacturer qualified to this slash sheet has characterized its devices to the requirements of [MIL-STD-750](#) method 1080 and as specified herein. Since each manufacturer's characterization conditions can be different and can vary by the version of method 1080 qualified to, the [MIL-STD-750](#) method 1080 revision version date and conditions used by each manufacturer for characterization have been listed here (see [table IV](#)) for information only. SEE (SEB and SEGR) conditions and figures listed in section 6 are current as of the date of this specification sheet, please contact the manufacturer for the most recent conditions.

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TABLE IV. Manufacturers characterization conditions.

Manufacturers CAGE	Inspection	MIL-STD-750		Sample plan
		Method	Conditions	
69210 (Applicable to devices with a date code of September 2009 and older)	SEE <u>1/</u>	1080	See MIL-STD-750 method 1080	3 devices
	Electrical measurements		I_{GSS1} and I_{DSS1} in accordance with table 1 , subgroup 2	
	SEE irradiation:		Fluence = $3E5 \pm 20$ percent ions/cm ² , Flux = $2E3$ to $2E4$ ions/cm ² /sec, Temperature = $25 \pm 5^\circ C$	
	2N7545U3 and 2N7547T3		Surface LET = 38 MeV-cm ² /mg $\pm 5\%$, range = 35 $\mu m \pm 7.5\%$, Br ion beam energy = 270 MeV $\pm 7.5\%$	
	2N7546U3 and 2N7548T3		In-situ bias conditions: $V_{DS} = -100 V$ and $V_{GS} = 20 V$ (typical 3.75 MeV/nucleon at Brookhaven National Lab Accelerator)	
	2N7545U3 and 2N7547T3		In-situ bias conditions: $V_{DS} = -200 V$ and $V_{GS} = 15 V$ $V_{DS} = -75 V$ and $V_{GS} = 20 V$ (nominal 3.86 MeV/nucleon at Brookhaven National Lab Accelerator)	
2N7545U3 and 2N7547T3	Surface LET = 61 MeV-cm ² /mg $\pm 5\%$, range = 31 $\mu m \pm 10\%$, I ion beam energy = 330 MeV $\pm 7.5\%$			
2N7546U3 and 2N7548T3	In-situ bias conditions: $V_{DS} = -100 V$ and $V_{GS} = 15 V$ $V_{DS} = -25 V$ and $V_{GS} = 20 V$ (typical 2.92 MeV/nucleon at Brookhaven National Lab Accelerator)			
2N7546U3 and 2N7548T3	In-situ bias conditions: $V_{DS} = -200 V$ and $V_{GS} = 10 V$ $V_{DS} = -50 V$ and $V_{GS} = 15 V$ (nominal 2.70 MeV/nucleon at Texas A & M Cyclotron)			

See footnotes at end of table.

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TABLE IV. Manufacturers characterization conditions - Continued.

Manufacturers CAGE	Inspection	MIL-STD-750		Sample plan
		Method	Conditions	
69210 (Applicable to devices with a date code of September 2009 and older)	SEE <u>1/</u>	1080	See MIL-STD-750 method 1080	3 devices
	Electrical measurements		I_{GSS1} and I_{DSS1} in accordance with table I , subgroup 2	
	SEE irradiation:		Fluence = $3E5 \pm 20$ percent ions/cm ² , Flux = $2E3$ to $2E4$ ions/cm ² /sec, Temperature = $25 \pm 5^\circ C$	
	2N7545U3 and 2N7547T3		Surface LET = 84 MeV-cm ² /mg $\pm 5\%$, range = 28 $\mu m \pm 7.5\%$, Au ion beam energy = 350 MeV $\pm 10\%$	
2N7546U3 and 2N7548T3		In-situ bias conditions: $V_{DS} = -100 V$ and $V_{GS} = 10 V$ $V_{DS} = -30 V$ and $V_{GS} = 15 V$		
			(typical 1.98 MeV/nucleon at Brookhaven National Lab Accelerator)	
			In-situ bias conditions: $V_{DS} = -200 V$ and $V_{GS} = 10 V$ $V_{DS} = -35 V$ and $V_{GS} = 15 V$	
			(nominal 1.89 MeV/nucleon at Texas A & M Cyclotron)	
	Electrical measurements		I_{GSS1} and I_{DSS1} in accordance with table I , subgroup 2	
Upon qualification, all manufacturers will provide the verification test conditions to be added to this table.				

1/ I_{GSSF1} and I_{DSS1} was examined before and following SEE irradiation to determine acceptability for each bias condition. Other test conditions in accordance with [table I](#), subgroup 2, may be performed at the manufacturer's option.

* 2/ Manufacturer performed heavy ion SEE(SEB/SEGR) test at Brookhaven and TAMU Radiation Effects Facility for the MOSFET technology devices in accordance with TM1080 of MIL-STD-750. No single event burnout (SEB) and Single event gate rupture(SEGR) were observed to surface LET as stated above table IV. Limits are characterized at initial qualification and after any design or process changes which may affect the SEE(SEB/SEGR) characteristics. For more information on SEE (SEB/SEGR) test results, customers are requested to contact the manufacturer.

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6.9 Request for new types and configurations. Requests for new device types or configurations for inclusions in this specification sheet should be submitted to: DLA Land and Maritime, ATTN: VAC, Post Office Box 3990, Columbus, OH 43218-3990 or by electronic mail at Semiconductor@dla.mil or by facsimile (614) 692-6939 or DSN 850-6939.

* 6.10 Amendment notations. The margins of this specification are marked with asterisks to indicate modifications generated by this amendment. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Custodians:

- Army - CR
- * Navy - SH
- Air Force - 85
- NASA - NA
- DLA - CC

Preparing activity:

DLA - CC

(Project 5961-2021-043)

Review activity:

- Army - MI
- * Air Force - 170

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at <https://assist.dla.mil>.